

CLAIMS

1. A package for an integrated circuit die comprising:
 - an integrated circuit die;
 - 5 a plurality of metal contacts adjacent to peripheral sides of the package; wherein each contact has a substantially planar first surface, an opposite substantially planar second surface, and a side surface between said first and second surfaces;
 - 10 wherein said first surface has a bond wire connected thereto, said second surface is exposed at a first external surface of the package, and said side surface includes a reentrant portion;
 - 15 and
 - an encapsulant material which covers the integrated circuit die and the reentrant portion of the side surface of each contact.
- 20 2. The package of claim 1, further comprising:
 - a die pad having a substantially planar first surface, an opposite substantially planar second

surface, and a side surface between the first surface and the second surface; and

wherein the side surface of the die pad has a reentrant portion, and the encapsulant material covers the reentrant portion of the side surface of the die pad.

5 3. The package of claim 2, wherein the second surface of the die pad is exposed at the first external 10 surface of the package.

4. The package of claim 2, wherein the die pad is internal to the package.

15 5. The package of claim 3, wherein each package has a rectangular perimeter and has four peripheral sides, and said contacts are aligned in a row along two opposite peripheral sides of the package.

20 6. The package of claim 3, wherein said contacts are aligned in a row along each of the four peripheral sides of the package.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
7010
7011
7012
7013
7014
7015
7016
7017
7018
7019
7020
7021
7022
7023
7024
7025
7026
7027
7028
7029
7030
7031
7032
7033
7034
7035
7036
7037
7038
7039
7040
7041
7042
7043
7044
7045
7046
7047
7048
7049
7050
7051
7052
7053
7054
7055
7056
7057
7058
7059
7060
7061
7062
7063
7064
7065
7066
7067
7068
7069
7070
7071
7072
7073
7074
7075
7076
7077
7078
7079
7080
7081
7082
7083
7084
7085
7086
7087
7088
7089
7090
7091
7092
7093
7094
7095
7096
7097
7098
7099
70100
70101
70102
70103
70104
70105
70106
70107
70108
70109
70110
70111
70112
70113
70114
70115
70116
70117
70118
70119
70120
70121
70122
70123
70124
70125
70126
70127
70128
70129
70130
70131
70132
70133
70134
70135
70136
70137
70138
70139
70140
70141
70142
70143
70144
70145
70146
70147
70148
70149
70150
70151
70152
70153
70154
70155
70156
70157
70158
70159
70160
70161
70162
70163
70164
70165
70166
70167
70168
70169
70170
70171
70172
70173
70174
70175
70176
70177
70178
70179
70180
70181
70182
70183
70184
70185
70186
70187
70188
70189
70190
70191
70192
70193
70194
70195
70196
70197
70198
70199
70200
70201
70202
70203
70204
70205
70206
70207
70208
70209
70210
70211
70212
70213
70214
70215
70216
70217
70218
70219
70220
70221
70222
70223
70224
70225
70226
70227
70228
70229
70230
70231
70232
70233
70234
70235
70236
70237
70238
70239
70240
70241
70242
70243
70244
70245
70246
70247
70248
70249
70250
70251
70252
70253
70254
70255
70256
70257
70258
70259
70260
70261
70262
70263
70264
70265
70266
70267
70268
70269
70270
70271
70272
70273
70274
70275
70276
70277
70278
70279
70280
70281
70282
70283
70284
70285
70286
70287
70288
70289
70290
70291
70292
70293
70294
70295
70296
70297
70298
70299
70300
70301
70302
70303
70304
70305
70306
70307
70308
70309
70310
70311
70312
70313
70314
70315
70316
70317
70318
70319
70320
70321
70322
70323
70324
70325
70326
70327
70328
70329
70330
70331
70332
70333
70334
70335
70336
70337
70338
70339
70340
70341
70342
70343
70344
70345
70346
70347
70348
70349
70350
70351
70352
70353
70354
70355
70356
70357
70358
70359
70360
70361
70362
70363
70364
70365
70366
70367
70368
70369
70370
70371
70372
70373
70374
70375
70376
70377
70378
70379
70380
70381
70382
70383
70384
70385
70386
70387
70388
70389
70390
70391
70392
70393
70394
70395
70396
70397
70398
70399
70400
70401
70402
70403
70404
70405
70406
70407
70408
70409
70410
70411
70412
70413
70414
70415
70416
70417
70418
70419
70420
70421
70422
70423
70424
70425
70426
70427
70428
70429
70430
70431
70432
70433
70434
70435
70436
70437
70438
70439
70440
70441
70442
70443
70444
70445
70446
70447
70448
70449
70450
70451
70452
70453
70454
70455
70456
70457
70458
70459
70460
70461
70462
70463
70464
70465
70466
70467
70468
70469
70470
70471
70472
70473
70474
70475
70476
70477
70478
70479
70480
70481
70482
70483
70484
70485
70486
70487
70488
70489
70490
70491
70492
70493
70494
70495
70496
70497
70498
70499
70500
70501
70502
70503
70504
70505
70506
70507
70508
70509
70510
70511
70512
70513
70514
70515
70516
70517
70518
70519
70520
70521
70522
70523
70524
70525
70526
70527
70528
70529
70530
70531
70532
70533
70534
70535
70536
70537
70538
70539
70540
70541
70542
70543
70544
70545
70546
70547
70548
70549
70550
70551
70552
70553
70554
70555
70556
70557
70558
70559
70560
70561
70562
70563
70564
70565
70566
70567
70568
70569
70570
70571
70572
70573
70574
70575
70576
70577
70578
70579
70580
70581
70582
70583
70584
70585
70586
70587
70588
70589
70590
70591
70592
70593
70594
70595
70596
70597
70598
70599
70600
70601
70602
70603
70604
70605
70606
70607
70608
70609
70610
70611
70612
70613
70614
70615
70616
70617
70618
70619
70620
70621
70622
70623
70624
70625
70626
70627
70628
70629
70630
70631<br

a plurality of metal contacts adjacent to peripheral sides of the package;

5 wherein each contact has a substantially planar first surface, an opposite substantially planar second surface, and a side surface between said first and second surfaces;

10 wherein said first surface has a bond wire connected thereto, said second surface is exposed at a first external surface of the package, and said side surface includes a reentrant portion;

15 a die pad upon which the integrated circuit die is placed, said die pad including a peripheral side surface; and

20 an encapsulant material which covers the integrated circuit die and the side surfaces of each contact and the die pad; and

wherein the side surface of each contact includes a means for enhancing the connection between the encapsulant material and the contact, and the side surface of the die pad includes a means for enhancing the connection between the encapsulant material and the die pad.

12. A leadframe for making an encapsulated integrated circuit die package comprising:

5 a frame;

a die pad within and connected to the frame,

wherein said die pad has a side surface;

10 a plurality of substantially planar tabs

which extend from the frame toward the die pad

without contacting the die pad, wherein each tab

includes a side surface; and

15 wherein the side surfaces of the die pad and tabs include a reentrant portion.

13. The leadframe of claim 12, wherein the side surfaces of the die pad and tabs include a central peak.

14. The leadframe of claim 12, wherein the side surfaces of the die pad and tabs include a central depression.

15. The leadframe of claim 12, wherein the die pad and tabs have a first surface, and the side

surfaces of the die pad and tabs include a lip adjacent to the first surface, and a reentrant orthogonal portion adjacent to said lip.

5 16. The leadframe of claim 12, wherein the side surfaces of the die pad and contacts include asperities.

10 17. A leadframe for making a plurality of encapsulated integrated circuit die packages comprising:
15 a plurality of die pads, wherein each die pad has a side surface;
 a plurality of interconnected frames in a matrix, wherein one of said die pads is within and connected to each of the frames; and
 a plurality of substantially planar tabs which extend from each frame toward the die pad within the particular frame without contacting the die pad; and

20 wherein the side surfaces of the die pads and tabs include a reentrant portion.

18. The leadframe of claim 17, wherein the side surfaces of the die pads and tabs include a central peak.

5

19. The leadframe of claim 17, wherein the side surfaces of the die pads and tabs include a central depression.

10

20. The leadframe of claim 17, wherein the die pads and tabs have a first surface, and the side surfaces of the die pads and tabs include a lip adjacent to said first surface, and a reentrant orthogonal portion adjacent to said lip.

15

21. The leadframe of claim 17, wherein the side surfaces of the die pads and contacts include asperities.

20

22. A method of making an integrated circuit die package comprising:

providing a substantially planar metal leadframe, said leadframe including a frame;

wherein a substantially planar die
pad is within and connected to the
frame, and substantially planar tabs
extend from the frame toward the die pad
without contacting the die pad; and
5 wherein the die pad and tabs each
have a first surface, an opposite second
surface, and a side surface, and the
side surfaces of the die pad and tabs
10 include a reentrant portion;
placing an integrated circuit die on the
first surface of die pad;
electrically connecting the integrated
circuit die to the first surface of the tabs;
15 applying an encapsulant material onto the
frame so that the integrated circuit die, the
first surfaces of the die pad and tabs, and the
side surfaces of the die pad and tabs are covered
with the encapsulant material, but the second
surfaces of the tabs are not covered;
20 hardening the encapsulant material; and
cutting the encapsulated frame so that the
die pad and tabs are severed from the frame, a

completed package including a die, a die pad, and severed tabs is detached from the leadframe, and said severed tabs are adjacent to peripheral sides of the package.

5

23. The method of claim 22, wherein the second surface of the die pad also is not covered with encapsulant material.

10

24. The method of claim 23, further including cutting encapsulant material to form the peripheral sides of the package.

15

25. The method of claim 24, wherein the cutting is done by sawing.

20

26. The method of claim 23, further comprising plating the second surfaces of the die pad and tabs with a metal after applying the encapsulant material.

27.

27. The method of claim 22, further comprising connecting the leadframe to electrical ground.

28. A method of making a plurality of integrated circuit packages comprising:

5 providing a substantially planar metal leadframe, said leadframe including a plurality of interconnected frames in a matrix;

wherein a substantially planar die pad is within and connected to each of the frames;

10 wherein a plurality of substantially planar tabs extend from each frame toward the die pad within the frame without contacting the die pad;

15 wherein the die pads and tabs each have first surface, an opposite second surface, and a peripheral side surface; and

20 wherein the side surfaces of the die pads and tabs include a reentrant portion;

placing an integrated circuit die on the first surface of each die pad;

425668

electrically connecting each integrated circuit die to the first surface of the tabs which extend toward the particular die;

5 applying an encapsulant material onto each of the frames so that the integrated circuit dies, the first surfaces of the die pads and the tabs, and the side surfaces of the die pads and tabs are covered with the encapsulant material, but the second surfaces of the tabs are not covered;

10 hardening the encapsulant material; and

cutting the encapsulated frames so that the die pads and tabs are severed from their respective frames, a plurality of completed packages each including a die, a die pad, and 15 severed tabs are formed, and the second surfaces of the severed tabs of each package are adjacent to peripheral sides of the package.

29. The method of claim 28, wherein the second 20 surface of the die pad also is not covered with encapsulant material.

30. The method of claim 29, wherein the cutting
is done with by sawing.

31. The method of claim 29, further comprising
5 plating the second surfaces of the die pads and tabs
with a metal after applying the encapsulant material.

32. The method of claim 28, wherein a single
block of encapsulant material covers all of the dies,
10 and further including cutting encapsulant material to
form the peripheral sides of the packages.

33. The method of claim 28, wherein each die is
within a separate unit of encapsulant material.

15

34. The method of claim 28, further comprising
connecting the leadframe to electrical ground.

35. A method of making a leadframe comprising:
20 chemically etching a metal sheet to form a
frame;
wherein a die pad is within and connected to
the frame, tabs extend from the frame toward the

die pad without contacting the die pad, and the die pad and tabs each have a peripheral side surface which includes a reentrant portion.

5 36. A method of making a leadframe comprising:
progressively stamping a metal sheet to form
a frame;

10 wherein a die pad is within and connected to the frame, tabs extend from the frame toward the die pad without contacting the die pad, and the die pad and tabs each have a peripheral side surface which includes a reentrant portion.